A Brief Tutorial on Studio Monitors

PreSonus®

Selecting the right reference monitors and setting them up correctly in your mixing environment is one of the most critical elements in creating mixes that will translate to any speaker system. Just about anyone who has ever mixed a record has experienced the frustration of getting a mix that sounds amazing in their mixing environment, only to pop it onto their car stereo and wonder in confusion, "Hey! Where did the lead guitar go?" The likely culprit is their studio setup. PreSonus has put together this brief tutorial to help you pick out the best studio monitors for your budget and set them up in your mixing environment so that you get the best results.

Next to your ears, your studio monitors are the most important part of your studio. Investing in a high-quality studio monitors will make mixing easier and less fatiguing and will help you to become a better engineer. Fortunately, a good monitoring setup is possible on any budget.

High-quality studio monitors accurately reproduce frequencies across the audio spectrum. Why is a flat frequency response important? Mixing on speakers that don't provide an accurate frequency response is like trying to drive a car with a very dirty windshield. Colors will have the wrong hue, details in the landscape won't be visible, and blind spots will be exaggerated. A flat frequency response helps you to more accurately hear what has been recorded.

In the past, many affordable reference monitors were designed to make music more pleasant to listen to, which meant that they boosted or cut certain frequencies for a more flattering aesthetic result. The good news is that there are now many affordable options that provide a flat frequency response.

Selecting the Right Speaker

The first big consideration when selecting studio monitors is your mixing environment. Unfortunately, for many project-studio owners, this can't be easily changed.

How big is your room? If you're mixing in a small room, a studio monitor with an eight-inch woofer might overpower the space. On the flip side, if you're mixing in a large room, you'll want a bigger speaker so you can run your monitor system more efficiently.

How close are your neighbors? If you're mixing in an apartment, you may want to consider smaller speakers that sound great at lower volumes.

Once you've evaluated your listening environment, go listen to some speakers at your local music store. Be sure to take along a comprehensive assortment of well-mixed recordings with which you're familiar and that reflect the type of music you'll mix on your new monitor system. Keep in mind that MP3s can sound brittle and harsh on higher-fidelity speakers, so don't use compressed files.

You should also keep in mind that the listening environment in a music retailer is not always optimal. If you think this might be the case, it may be a good idea to rent two or three of the potential candidates and

take them for a test drive in your mix space before purchasing your final selection.

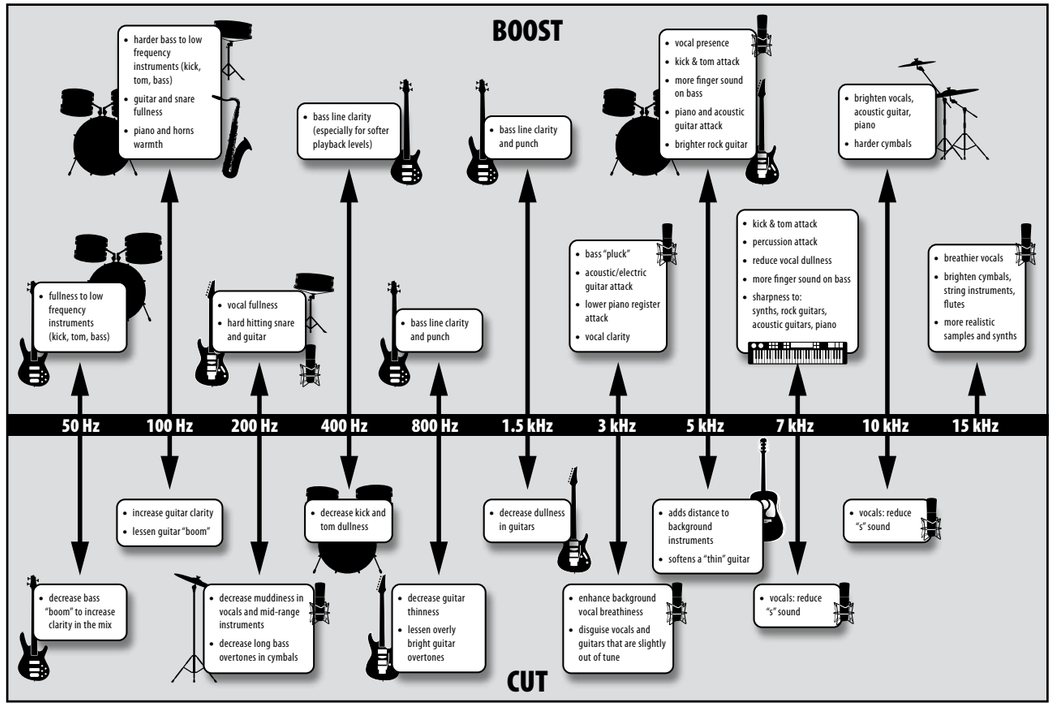
The most important elements to listen for are:

- **Bass response.** Is it tight and controlled or boomy and poorly defined? A well-designed studio monitor will deliver punchy, musical bass. If you can't hear the note, just "feel" it, it's probably best to move on to another option.
- **Mid-frequency response.** This can be challenging to hear because the notorious scooped "smiley face" EQ that's applied to nearly every consumer speaker carves out the mids, so you may not be used to hearing them. A well-designed studio monitor will have an even midrange. This is important because vocals and most instruments "live" in the midrange. Make sure you can hear the attack of the snare drum and that the vocals and guitars are vibrant and present.
- **High-frequency response.** Are the cymbals and hi-hats crisp and shimmery? Or do they have a brittle edge? A well-designed studio monitor will provide crisp high end without harshness. You should also be able to hear reverb tails and the "breath" in the vocal.
- **Linear frequency response.** Do some instruments seem more exaggerated than others? Does the vocal seem to vanish as it navigates the notes in the melody? A well-designed studio monitor will provide a smooth, linear frequency curve throughout its reproduction range. A monitor like this will ensure that your mix will translate well from room to room and speaker to speaker.
- **Stereo image.** A well-designed studio monitor will provide a wide stereo image. Close your eyes. Can you hear the pan placement of the drums? Can you "hear the room" in which the music was recorded? The better the stereo imaging is on your studio monitors, the easier it will be to separate the components in your mix.

Finally, and most important, your personal taste will always be the final determining factor. There is no right or wrong answer. You may love the top end on a pair of studio monitors and mix great records using them, while someone else finds that same top end harsh and edgy. Choose the monitors that work best for your room, the musical genres you'll work in, and the way you mix. Go with what your ears tell you.

Speaker Basics

You should familiarize yourself with a few terms before going studio-monitor shopping. These will help you to better understand what type of speaker will best suit your needs.



Driver. The driver is the part of the speaker that produces sound waves. The better the quality of the driver, the better it will reproduce sound waves and take the wear and tear a busy mix engineer can dish out.

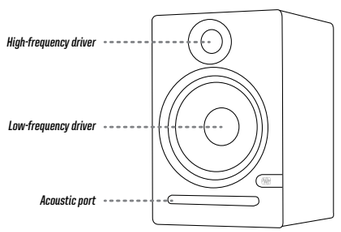
High-frequency driver or "tweeter." This is the part of the speaker that is responsible for high- and upper mid-frequency reproduction. High-quality drivers are usually constructed of materials like titanium, silk, aluminum, and beryllium. There are several different tweeter designs. Two of the most common types found in studio monitors are:

- **Soft Dome.** This round shape of this type of design radiates sound with a wide dispersion pattern to create a larger sweet spot. The larger the diameter of the dome, the wider the sweet spot. Usually made from a high-quality textile, like the silk (as used in PreSonus Eris-series monitors), these designs are known for their smooth and refined sound.
- **Air Motion Transformer (AMT).** This design employs an ultra-light material that is inlaid with an aluminum circuit that functions as a voice coil. This material is folded like an accordian and moves like a bellows, launching sound waves from the two surfaces rushing toward one another. This design provides a much larger projection area than a traditional dome tweeter, so its sound coverage is much larger. For example, the 6.8-inch^2 AMT tweeter in the PreSonus R65 and R80 provides coverage equivalent to that of a 3-inch dome tweeter. Because the AMT design is so efficient, it is capable of a very fast transient response, even at ultra-high frequencies. This allows you to hear more of the "air" and "space," providing a much more natural sound.

Low-frequency driver or "woofer." This driver produces the low-mid and low frequencies. Because it is responsible for producing larger sound waves, a woofer requires a higher-power amp than tweeters do. High-quality low-frequency drivers are usually made from very tough and stiff materials, like Kevlar® or glass composite. Both materials are able to withstand the abuse a woofer takes, and each has its own unique set of benefits. A Kevlar driver provides a constant dispersion pattern, using its woven pattern to break up reflected energy, creating a transparent, cohesive sound. A glass-composite speaker is lighter, more efficient, and will reproduce the same volume with less power, and is able to better reproduce transients because of its fast response.

Note: *In a two-way system, the high- and low-frequency elements share the responsibility for mid-frequency reproduction. A three-way system provides a separate driver that is dedicated to mid-frequency reproduction. While three-way studio monitors aren't as common as two-way systems in the studio monitor world, they are not unheard of, so it's important to mention the difference.*

Acoustic Port. Also known as the "bass reflex port," an acoustic port redirects the inward pressure produced by the outward movement of the speakers. The backward motion of the diaphragm pushes sound waves out of the port and boosts the overall sound level. Ported speaker designs are much more efficient because the power moving the driver produces two sound waves instead of one.



Active vs. Passive. Active studio monitors have onboard power amplification that has been designed to optimally power the drivers. This takes the guesswork out of choosing the right speaker/amp combination, because engineering teams have ensured an ideal match. Passive studio monitors do not have an onboard amp and require external power. Some studio monitors, like the Eris™ E4.5, have the power amps for both speakers in one cabinet. In general, a higher power rating (in watts) will result in more headroom and a stronger, cleaner output.

Crossover. The crossover separates the frequencies coming into a speaker and distributes them appropriately to the woofer and tweeter. This helps the speaker run more efficiently and reproduce the frequency spectrum more reliably.

Biamplification. A biamped studio monitor has two amplifiers inside: one dedicated to powering the high-frequency driver and the other dedicated to powering the low-frequency driver. By separating the frequencies before they hit the amplifiers, a biamped system removes one of the major sources of intermodulation distortion. The resulting sound is more open and clear and less fatiguing.

Other Variations

In addition to conventional two-way designs like the PreSonus Eris E4.5, E5, and E8, there are other configurations that offer unique benefits:

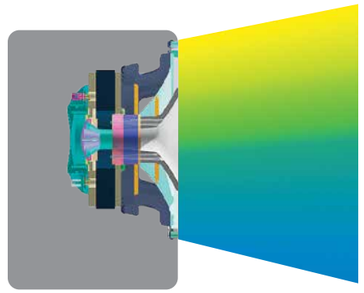
Midwoofer-Tweeter-Midwoofer (MTM). MTM configurations such as the PreSonus Eris E44 and E66 feature two midrange drivers that cover the same frequency range, with a high-frequency driver nested between them. Because the two woofers cover the same frequency range and are placed so that their acoustic centers are less than one wavelength apart, the combined signal of the two drivers propagates

forward as a single waveform. This provides a much more dynamic output than their relatively small size would normally afford. The two woofers also work to partially contain the dispersion of the tweeter, minimizing phase displacement. This results in smoother frequency response and an ultra-wide, detailed stereo soundstage.

Eris E66

Coaxial speakers. A coaxial speaker like the one used in the Sceptre™ S6 and S8 places the high-frequency driver in the center of, and on the same axis as, the low-frequency driver, which is similar to the way the human ear works. Coaxial designs offer a symmetrical response both horizontally and vertically. This means a wider "sweet spot" that is more consistent throughout the room. Properly designed coaxial speakers can also offer a seamless crossover transition because of their symmetrical response.

Because the high- and low-frequency elements come from the same point source, coaxial speakers can offer an ultra-wide sweet spot, more realistic and reliable transient reproduction, and an amazing 3D soundscape. However, to get the benefits that a coaxial speaker can theoretically provide, great care must be taken to ensure that the phase- and time-alignment are accurate. Copious amounts of processing, such as provided by the DSP onboard each Sceptre studio monitor, is required to run the alignment algorithms and FIR filters needed for optimal coaxial performance.



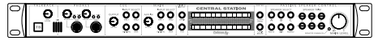
Coaxial design

One Pair or Two?

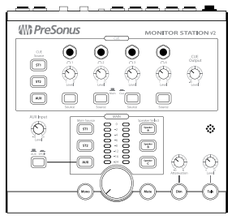
As mentioned earlier, listening to your mix on multiple pairs of reference monitors can provide new insights into your mix by giving you a different perspective. If you've decided to purchase another set of stereo monitors, choose speakers that are different enough from each other to get the result you desire. For example, if your main mix speakers are eight-inch coaxial monitors, like the Sceptre S8, you may also want to purchase a smaller pair of traditional two-way monitors like the Eris E5. A set-up like this will allow you to mix on monitors with detailed bass and a lifelike, three-dimensional Z-plane and reference it on a smaller pair of monitors with narrower stereo image and frequency range to see how it will translate across various systems.

If you add a second or third pair of monitors to your mixing rig, you'll also need to add some sort of speaker-management system, like the PreSonus Central Station Plus or Monitor Station V2. These products not only allow you to easily compare your mix on different monitor pairs, they also provide source switching so that you can compare your mix to another mix in the same genre. Some speaker-management systems, like those made by PreSonus, are also designed to become the central hub for your studio and will provide extra headphone mixes and talkback systems, so they're well worth the investment.

Central Station PLUS



Monitor Station V2



The Sweet Spot: How Wide is Wide?

When shopping for studio monitors, you will most likely read a lot about "the sweet spot." This is the middle position between the two sides of a stereo system, where the speakers overlap, and it is where the stereo image will be the best. In general, the wider the sweet spot, the better the stereo imaging will be. While all studio monitors are designed to perform in a stereo system, some variations of studio monitors are designed to provide exceptional stereo imaging.

If creating a detailed, multi-dimensional stereo field is part of your mix philosophy, you may want to consider one of these variants as your main monitoring system:

- **Wide: AMT monitors** like the PreSonus R65 and R80 will provide a wider stereo image than a conventional two-way monitor because of their unique high-frequency driver design's superior coverage area and its ability to reproduce lifelike audio.
- **Ultra-wide: MTM monitors** like the Eris E44 and E66 utilize their dual woofers to contain the dispersion of the tweeter centered between them to limit phase displacement and create an ultra-wide stereo field.
- **Ultra-width plus depth: Coaxial speakers** like the Sceptre S6 and S8 utilize their symmetrical response and single acoustic center to provide the widest and most three-dimensional stereo image.

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Selecting Subwoofers

Subwoofers have become common in car and home stereo systems. Because ultimately your mix is going to played in someone's car or through their desktop computer system, you should consider verifying the deep bass content in your mix, especially if the target listener for your mix is going want to hear and feel that extended low end.

Adding a subwoofer to your system will make the wiring and calibration of your monitoring system a bit more complex, but when carefully tuned to the stereo full-range system, a subwoofer will naturally extend the low end without overshadowing your full-range system. A properly calibrated 2.1 system can improve your mixing environment by offloading much of the bass-frequency reproduction to the sub, letting the woofers of the full-range system focus on the low mids.

Some subwoofers, like the PreSonus Temblor™ T10, let you momentarily bypass the subwoofer with a footswitch, allowing you to compare your mix with or without the subwoofer engaged. This is very important, as it lets you ensure that the bass in your mix will work equally well on stereo systems.

Some subwoofers, like both the PreSonus Temblor T10 and T8, provide an onboard variable lowpass filter. This allows you to fine tune the crossover transition between your full-range system and your subwoofer, ensuring a more even frequency response. If your studio subwoofer does not provide this feature, you should consider purchasing an external crossover for this purpose.

Temblor T10

Positioning Your Full-Range Monitors

You've found the best studio monitors for your budget and your application. Now all you have to do it plug them in, right?

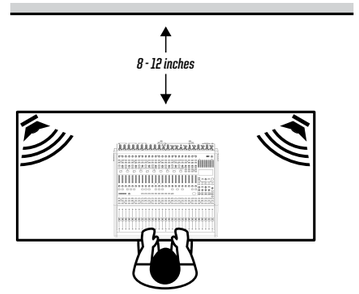
Not exactly. Like everything in recording and mixing audio, careful preparation will give you a better result. Luckily, perfecting your mixing environment only takes a little know-how, planning, and time.

Positioning your monitors and listening position is crucial to creating an accurate mixing environment. The first step is to pick the best possible arrangement for your workstation and speakers.

This section will take you through a few best practices. Like all rules, there are exceptions and variations. When followed, these should provide you with a good starting point for your mixing environment. Once you have that set up, feel free to make changes as needed. Remember that even best practices will not work in every mix environment. Your goal is to find the best configuration for your room and your needs.

Set up your desk so that your speakers will be away from walls and corners.

Make sure that your speakers can be placed away from walls. Eight to twelve inches will be adequate to prevent sound waves from hitting the wall and reflecting back to you, causing phase cancellation and other potentially harmful acoustic interactions. This might not always be possible, and there are some ways to mitigate cramped mixing spaces. (We'll get to those in a minute; remember, these are just best practices.)



Minimum distance from walls

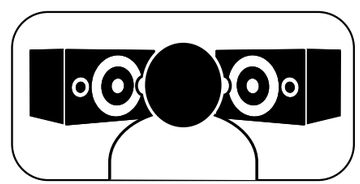
An added bonus of putting some distance between your speakers and the walls is that it gives you easy access to the back of your rig, which is never a bad thing.

Avoid setting up in a corner; this will help prevent the bass buildups that naturally occur when two reflective surfaces meet.

Vertical or horizontal?

Many studio monitors shouldn't be placed horizontally, as horizontal placement can degrade the stereo image, so it's important to read the monitors' documentation. Some monitors, like the PreSonus Eris E5, E8, E44, and E66, can be placed horizontally or vertically. When orienting your studio monitors horizontally, they should form a mirror image of each other, with the tweeters on the outside.

This is also true for MTM monitors like the Eris E44 and E66 when placed vertically. That is, they should form a mirror image of each other, with the tweeters on the outside.



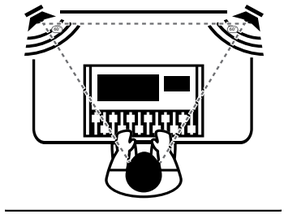
Proper horizontal placement

Whether or not the manufacturer recommends horizontal or vertical placement, you should always feel free to experiment. You may

find that you prefer the way a different orientation sounds in your space, even if it's not the one the manufacturer recommends.

Your speakers should form an equilateral triangle with your listening position.

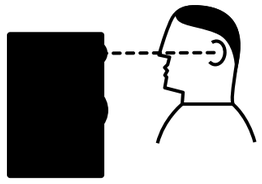
Whenever people talk about listening to speaker systems, they talk about the "sweet spot." As mentioned earlier, this is the middle position between the two sides of a stereo system, where the speakers overlap, and it is where the stereo image will be the best. Creating the sweet spot is relatively easy. Simply angle, or "toe-in," each speaker so that the tweeters form an equilateral triangle with your head—that is, the speakers are the same distance from each other as they are from you.



Proper listening position

The high-frequency driver should be the same height as your ears.

High-frequency content is much more directional than low frequency content. Because of this, you can more accurately hear what is happening if the high frequencies are directed at your ear. Once you have created the sweet spot, sit down and make sure that your ears are level with the center of tweeter.

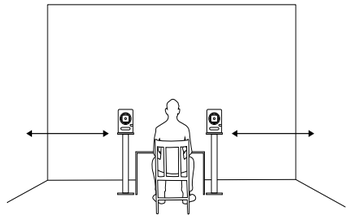


Proper speaker height

In some cases, especially with large speakers, placing the speakers vertically results in the tweeter being aimed too far above your ears. One way to solve this is to simply invert both monitor speakers so that the tweeters are on the bottom. It may look unusual but it works.

Situate your mix position symmetrically.

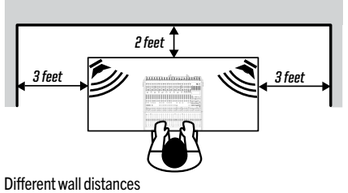
The center of a wall provides a more balanced listening position. Place your speakers so that they are the same distance from the sides of the room. That is, if your left speaker is six feet from the wall to the left and two feet from the wall behind, your right speaker should be six feet from the wall to the right and two feet from the wall behind. By centering your mix position, your monitor system will provide more reliable low-frequency intelligibility. In a rectangular room, it is best to set up along one of the long walls, especially in a smaller room. This will minimize problems caused by side wall reflections.



Centered mix position

The speakers should be a different distance from the back wall than from the walls on either side.

Just like it's not a good idea to set up your mix position in a corner, it's not a good idea to create a corner with your mix position. Make sure the distance from the speaker to the wall behind it is different than the distance from the side wall closest to it. For example, if your left speaker is six feet from the wall to its left, it shouldn't also be six feet from the wall behind it.



Different wall distances

Use the tools your monitors give you to overcome problems in your room.

Ideally, your mix space should be large enough to allow you to set up your listening position well away from walls and corners. But this is not always possible, especially if your mix environment also doubles as a bedroom, den, or family room. Luckily, some studio monitors, like all PreSonus full-range studio monitors, provide onboard controls to help mitigate this.

When a monitor is placed close to a wall, or in a corner, the low frequencies tend to be emphasized more than if the monitor is far from any room boundary; this effect is called "boundary bass boost." It is typically most pronounced if the monitor is in a corner and is less pronounced (but still present) if the monitor is near one wall.

Acoustic Space controls, like those on every PreSonus studio monitor, cut all frequencies below a specific frequency by a fixed amount, which can help with this problem. If you find that your monitors sound "muddy," or if your mixes lack low end everywhere but your mix environment, try these controls.

Monitor stands are worth the investment

Placing your speakers directly on your desk can limit their ability to produce clear, balanced audio because the sound waves coming from them are bouncing off a hard, reflective surface (your desktop) before they reach your ears. Desktop placement also puts most speakers below ear level, which is not ideal. Monitor stands can raise the speakers closer to ear level and help prevent early reflections from interfering with your listening environment.

In addition to traditional monitor stands, you can buy good desktop isolation stands that help solve these problems for tight mix spaces. Whatever monitor stand you purchase, be sure to follow the

best practices discussed earlier when placing them in your mix environment.

Calibrating Full-Range Monitors

After you have properly positioned your studio monitors and listening position, it is helpful to set all the levels in your studio so that you are optimizing every component. While not essential, taking the time to properly calibrate your speakers can be very helpful in this respect and will also give you a great starting point to troubleshoot or fine-tune your mixing environment.

The main purpose of speaker calibration is to ensure that a specific metered audio level in your DAW or on your mixer equals a predetermined SPL in your studio environment. Depending upon the method and reference levels used during calibration, proper calibration can help reduce unwanted noise, minimize the risk of damage to your studio monitors and to your ears, maximize the reference capabilities of different speaker types, and ensure you hear the audio as accurately as possible.

There are many methods for calibrating studio monitors. Which method is best for your studio depends on the nature of your mix environment, gear, clientele, and audio mixes. If you wish to calibrate your studio monitors using a different method than the one described here, we encourage you to do so. The important thing is not the way you calibrate your environment but that your environment has been calibrated—even if you only use your ears, common sense, and your favorite recording.

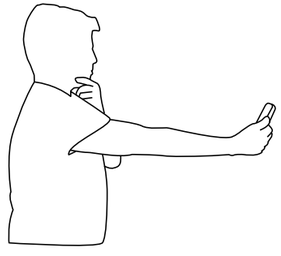
Nearly every calibration method has one thing in common: test tones. There are many different types of test tones. The one we'll discuss here is full-bandwidth pink noise. With full-bandwidth pink noise, every frequency band is present at exactly the same level, so it is ideal for speaker calibration, room analysis, and many other types of acoustic measurements. Full-bandwidth pink noise samples can be purchased from your local electronics or entertainment retailer or downloaded from a variety of free Web sites.

Some DAW applications, including PreSonus Studio One, feature a tone-generator plug-in that offers a wide range of test tones, including pink noise. If you are using a DAW for tracking and mixing, using it as a calibration source is ideal.

Studio One Tone Generator

When calibrating reference monitors in a studio, the acoustic level or sound pressure level (SPL) should be measured from the mix position at seated ear height. There are an assortment of great SPL metering apps on the market for smartphones, and many are free! You can also find accurate SPL meters at your favorite local electronics-supply store.

The SPL meter should be held at arm's length, with the microphone pointed at the center point between the left and right speakers (where your head will be), angled at 45 degrees to ensure an accurate reading. If your SPL meter is also your cell phone, make sure your finger or cell phone case isn't covering the mic!



Hold SPL meter at arm's length

You should calibrate the right and left monitors independently to ensure that both monitors are set to the same acoustic level. This will ensure that your stereo mixes are balanced and will translate well across different speaker systems.

When two or more monitoring systems are calibrated using the same method, each system should generate the same acoustic level when given the same input source. This is especially important when referencing your mix on different sets of monitors (such as toggling between Speaker A and Speaker B for comparison). Just like a single system, the left and right monitors of each monitor pair should be calibrated independently to ensure that each speaker is set to the same level.

Level calibration is especially important when you have two or more speaker pairs because there should not be a change in loudness level when switching between the different sets of speaker. In an incorrectly calibrated studio, the acoustic level will jump when toggling between the different systems and lead to a potentially inaccurate perception of the consistency and quality of your mix.

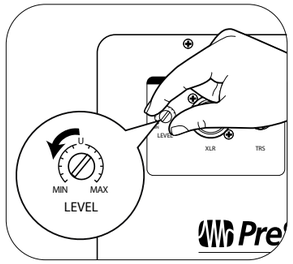
Calibrating Using 85 dB SPL "Standard" Reference

This method relies on technical data rather than on subjective listening and is consequently one of the most common calibration standards. The goal of this calibration method is ensure that when the output meters in your DAW or mixer register 0 dB, the SPL in your mix position is 85 dB.

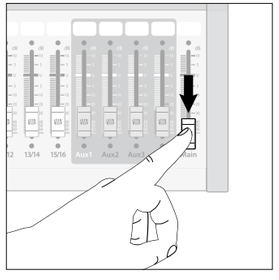
This section will take you through the basics of "Standard" Reference calibration. To calibrate your speakers you will need an SPL meter and some pink noise. If your monitor system also includes a subwoofer, you will find continued calibration instructions the section "Calibrating Subwoofer Level."

1. Connect the main outputs of your audio source to your studio monitors. The left output should be connected to the speaker on your left. The right output should be connected to the speaker on your right.

2. Begin by turning the input sensitivity of your studio monitors to the lowest setting.



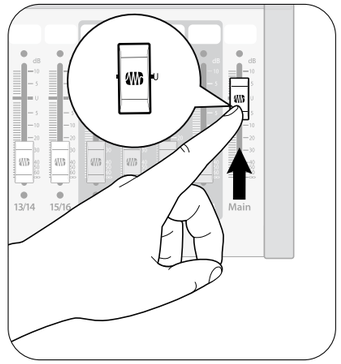
3. Turn the output of your audio source (audio interface, mixer, or speaker-management device) to its lowest setting.



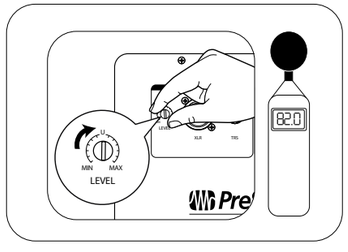
Note: If you have any outboard processors (EQs, limiter, etc.) connected between the audio source and your monitors, disconnect or bypass them. If your audio source is a mixer, make sure that it is zeroed out.

4. Play 20 Hz to 20 kHz full-bandwidth pink noise at 0 dB through the outputs of your primary audio source.

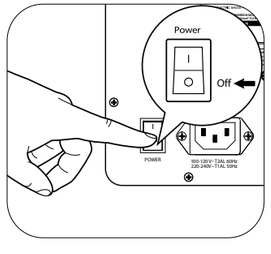
5. Turn up the outputs of your primary audio source to their unity gain setting. "unity gain" is the setting at which the signal level is neither boosted nor attenuated. It is usually marked by a "0" or a "U" on the audio device's level fader or knob. In many digital interfaces and digital devices, the device's maximum level is also its unity gain setting. Please consult your audio device's user's manual or the manufacturer's Web site for more information on its levels and adjustments. You should not hear the pink noise. If you do, repeat step 2.



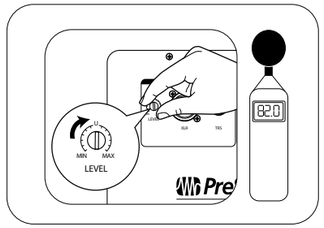
6. Begin slowly increasing the input sensitivity (volume) of your left speaker until the acoustic level of the test tone playing reaches 82 dB SPL. When both speakers play simultaneously, the overall SPL will increase by about +3 dB (85 dB).



7. Power down your left speaker.



8. Slowly increase the input sensitivity (volume) of your right speaker until the acoustic level of the test tone playing reaches 82 dB SPL.



9. Stop the pink noise and turn your left speaker back on. Play some program music you are familiar with through your speakers and sit down in your mix position. You may need to fine-tune your speaker placement until the sound is balanced and you have a nice, wide sweet spot from which to mix.

Note: If 85 dB is too loud for your room, either because of noise constraints or because the room is too small, you can redo the above calibration steps and dial in each speaker to 79 dB instead. The important thing is that both speakers are set to the same SPL level, not the level itself.

Room Acoustics

Well-designed studio monitors are engineered to reproduce an input signal with extreme fidelity, maintaining near-flat frequency and phase response at all levels up to the threshold of clipping. However, the performance of any monitor will be influenced by the acoustics of the space in which they operate. Difficult room acoustics, even with proper speaker placement, can interfere with achieving the highest fidelity your monitoring system can provide.

For example, if your room exaggerates high-frequencies, your mixes will lack life and feel flat elsewhere. If your room exaggerates low-end, that thundering tom roll, will lose all its thunder when you hand off your mix to your drummer to take a listen.

In most home-studio environments, the room is not designed to maximize the listening experience, so it's necessary to recognize and correct

what that space does to the sound in order to optimize the monitor system's performance. In general, the following physical features of a room can affect a sound system's performance:

- Room size
- Construction
- Reflectivity

Understand how the room affects your mix

- **Size.** The size of the room directly impacts how well certain frequencies will be reproduced. For example, if you measure a room diagonally, you will discover how well that room will be able to sustain low frequencies. This may seem odd until you think about the physical length of audio waves at various frequencies. For example, a 50 Hz wave is about 22.6 feet long. (To calculate how long an audio wave is, divide the speed of sound—1,130 ft./second—by the frequency. For a 50 Hz wave, 1,130/50 = 22.6 ft.) So a room that is 45 feet on the diagonal is going to regenerate low frequencies more effectively than a room that is 15 feet on the diagonal.

When a room's width or length correlates directly to the length of a waveform at a specific frequency, a standing wave can occur where the initial sound and the reflected sound begin to reinforce each other. Let's say we have a long, narrow room where the distance from one side to the other is 22.6 feet. When a 50 Hz wave bounces off the wall, the reflective wave travels right back along the same path and bounces off the other wall, and the cycle repeats. In a room such as this, 50 Hz reproduces very well—maybe too well. So when you're listening to your mix in that room, it will appear to have a heavy low end because the low frequencies are being exaggerated by the room acoustics. Since you hear exaggerated lows, you're likely to compensate for them, and when the mix is played elsewhere, it will lack low end.

- **Construction.** Low-frequency waves are powerful enough to cause the walls, ceiling, and even the floor to flex and move. This is called "diaphragmatic action," and it dissipates energy and strips away the low-end definition. So if your room's walls and floor are made of solid brick and concrete that don't vibrate much, the bass response is going to be much more powerful than if you're in a room where the walls are normal sheet rock construction and the floors are hardwood.

- **Reflectivity.** Another way a room interacts with sound waves is through reflectivity. Like most room anomalies, reflections can be good and bad. Consider the effect of a cathedral's reflections on a choir or a piano. This type of reverberation (reverb) is quite desirable for recording but not so much for mixing. If a speaker is placed near a reflective surface (such as a brick wall or window), the direct sound coming from the speaker and the reflected sound coming from the wall can arrive at the listener's ears out of phase with each other, causing cancellation and/or reinforcement. If they're 180 degrees out of phase with respect to each other, they will cancel each other out.

If you are setting up your mix environment in a reverberant space, position your speakers so that as much sound as possible is focused on middle of the room and steered away from reflective surfaces. You should also install acoustic treatment to lessen the impact of reflections at your listening position.

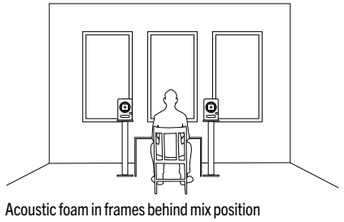
Mitigating Room Problems

Even the best room can use some acoustic treatment. This can be as simple as strategically positioning couches, bookcases, and rugs. In general, acoustic treatment falls into two categories: materials that absorb sound and materials that diffuse sound. Placing the correct type of acoustic treatment will reduce unwanted reflections that can impair the quality of your listening position.

- **Absorption.** Materials that absorb sound will help to reduce reflections. The best types of absorptive materials are generally dense and porous. Heavy cloth, acoustic foam, pillows, and fiberglass insulation are all examples of absorptive materials. This type of acoustic treatment is best for reducing the mid- and high-frequency energy bouncing around your room.

An easy trick to figure out whether and where you need absorption in your room is to sit down at your mix position and clap loudly. If you hear your clap reverberating around your room, you'll benefit from some acoustic absorption. Take a look around your room and look for potential culprits that could be reflecting the sound back at you. The usual suspects are the walls around you, including the wall behind your studio monitors and the ceiling above your head.

Acoustic foam is relatively inexpensive, can be purchased at your favorite music-equipment retailer, and comes in different thicknesses. Generally speaking, 2-inch foam will best reduce frequencies above 500 Hz; 4-inch foam can reduce frequencies all the way down to 250 Hz. Whatever the thickness, acoustic foam is easy to attach to the wall using spray adhesive or tack nails.



Acoustic foam in frames behind mix position

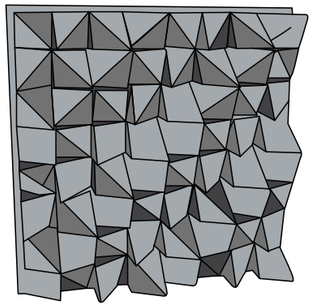
If you are in a space where you are worried about damaging your walls, you can purchase a shadow box at your local arts and crafts store and attach the foam to that instead. Once the foam is attached to the frame, you can hang it on your wall just like a picture.

With your high and mid frequencies tamed, you'll need to tackle low-frequency buildup. Uneven bass response is a notorious problem in project studios. Bass energy can build up in corners and other boundary points and make the bass response in your mix position muddy and ill defined.

Low-frequency energy behaves very differently than high and mid frequencies. Materials that absorb high and mid frequencies may not effectively absorb low-frequency energy and vice versa. To add to the problem, bass energy is not directional, so it can build up pretty much anywhere.

Bass traps are a special type of acoustic absorption material that reduces low-frequency resonance. Placing bass traps in your room's corners and other boundaries (like where the wall meets the floor or ceiling) is usually adequate, but if you're handy and don't want to damage your walls, you can construct a mobile bass trap by wrapping layers of carpet and carpet padding around a large frame or bookcase and mounting castors on the bottom. This will allow you to create a custom mixing environment without permanently altering your room. The Internet is a great resource for other creative ideas to build custom acoustic treatment.

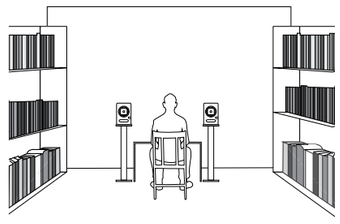
• **Diffusion.** In general, rooms that are 10 x 10 feet or less will get great results with some combination of absorption material. If you are mixing in a larger space, you might want to add some diffusers to deaden it. Sound-wave diffusers are designed to break up standing waves by reflecting the waves at different angles. These panels can be mounted to the wall or ceiling as necessary and can get rid of "flutter echo."



Acoustic diffuser panel

With two parallel reflective surfaces in a room, such as opposing walls or the floor and ceiling, there is always the possibility of successive, repetitive reflections that are equally spaced in time. Known as "flutter echoes," these reflections can produce a perceived pitch or timbre that colors what you're mixing. This can also reduce intelligibility. Diffusors can break up flutter echoes by reflecting the sound waves in different directions so that the repetitive reflections are eliminated.

Bookworms have a bit of an advantage with this type of acoustic treatment, as bookcases filled with books provide multiple absorbent, different-shaped objects that break up standing waves and flutter echoes. So if the problem is two parallel walls, putting your library on one or both walls may eliminate the need for additional acoustic treatment.



Use your books as a diffuser wall

Adding a Subwoofer

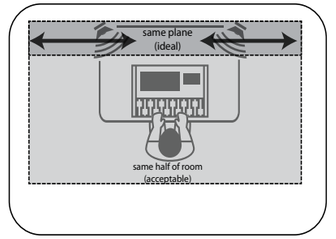
Whether you add a subwoofer to your existing monitoring system, or you purchase a complete 2.1 system, it's a good idea to dial in your full-range system first, especially if you're starting from scratch. This will make it easier to identify and fix problems before you get too many components in the mix. Once you have your full-range monitors placed and calibrated and your room acoustics tamed, adding a sub will be an easier proposition.

Temblor T8

Find the right spot for your subwoofer

The goal of proper subwoofer placement is to set up your system so that your subwoofer acts as a natural extension of your full-range monitors without boosting the overall bass response of your room or exaggerating any one frequency or frequency range. Because low frequencies are not directional—that is, humans cannot perceive the direction from which low frequencies are coming— you aren't limited to placing it facing the mix position.

A quick way to find the best location for your subwoofer is to temporarily place it in the mix position and play some program material that contains a lot of bass. Move around the half of the room where your full-range monitors are positioned until you find the spot where the bass sounds best, focusing on areas that on the same plane as your studio monitors. Again, it's important to remember that low frequencies are not directional, so placing the subwoofer beside you will not be an issue. However, try to keep your subwoofer on the same plane as your full-range monitors. This will help to minimize phase issues.



In general, you will want to avoid placing your subwoofer too near to reflective surfaces, like a wall or in a corner, as this will exaggerate the bass energy and make your monitor system sound "boomy." But every room is different, and some subwoofers perform just fine near a wall, so use your ears rather than your eyes.

Once you find the place in the room where the bass sounds the smoothest, place your subwoofer in that spot, return to the mix position, and listen again. You may need to adjust the location; just keep making small adjustment (a foot or so at a time) until the bass response sounds as even as possible. Don't locate your subwoofer where it will exaggerate frequencies, as this will have the opposite effect on your mix. For example, if your system has a bump around 100 Hz, what you hear will not accurately reflect what is in your mixes, so that massive kick-drum punch you hear in your mix environment won't be there when you listen in your car.

Calibrating Subwoofer Level

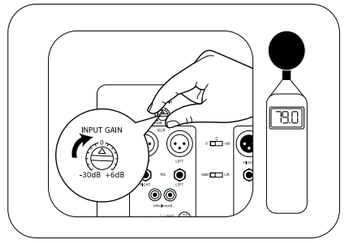
Just as it is important to make sure your full-range monitors are calibrated to the same level, you must ensure that your subwoofer is calibrated to match the full-range speakers. There is no need to recalibrate your studio monitors if you followed the 85 dB standard reference described earlier. If you are connecting your full-range system to the outputs of your sub, rather than to the outputs of your audio source, you should recalibrate your full monitor system.

1. Turn your subwoofer input level to its lowest setting and power down your full range monitors.

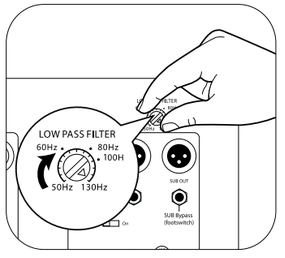
2. Play 20 Hz to 20 kHz, full-bandwidth pink noise at 0 dB through the outputs of your primary audio source.

3. Turn up the outputs of your primary audio source to their Unity Gain setting.

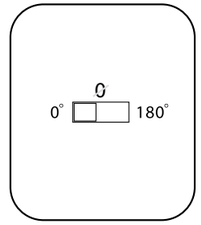
4. Begin slowly increasing the input sensitivity of your subwoofer until the acoustic level of the test tone reaches 79 dB SPL. Again, take your SPL measurement holding your meter at arm's length at a 45-degree downward angle, where your head will be.



5. If your subwoofer has a variable lowpass filter, set the filter to its highest frequency. This will create an overlap between your subwoofer's and your full-range system's frequency responses.



6. Turn your full-range monitors back on, play program music with a lot of bass in it through your new 2.1 system, and experiment with the polarity switch on your subwoofer to see which position provides the best bass response at your mix position. Leave the polarity switch in the position that provided the loudest bass response. This means that your subwoofer is in phase with your full-range system.



Note: If you set each full-range model to a lower level than 82 dB, you will want to do the same with your subwoofer. For example, if you set each full-range monitor to 79 dB, reduce your subwoofer by -3 dB as well (to 76 dB).

Setting The Crossover Transition

Many full-range monitors (like the Eris, R-series, Sceptre lines) provide a highpass filter for bass management. These highpass filters are usually not fully variable but often a few different frequency-cutoff options will be available.

Some subwoofers (like the Temblor T8 and T10) also provide a highpass filter on the outputs for this purpose.

Depending on the system, leaving frequency content below 60 to 120 Hz in your full-range monitors can introduce destructive cancellation and reinforcement with the highest frequencies that are reproduced by your subwoofer. Using a highpass filter on your full-range monitors will remove these frequencies and help you to create a more seamless crossover transition with your subwoofer.

If your subwoofer, like the Temblor series, provides a variable lowpass filter, your job is made a little easier in that you have more control over the crossover point.

The first rule of thumb when dialing in the crossover transition in your 2.1 system is to listen. Depending on the frequency range of your full-range monitors and your subwoofer,

you may not have to do much. For example, if the lowest frequency your full-range monitors can reliably reproduce is between 70 and 80 Hz, you may not have to do anything but plug in your subwoofer. If, however, your full-range monitors are accurate below 60 Hz, you will most likely need to use the following instructions to configure your crossover network.

If your subwoofer provides a variable lowpass filter:

1. Set the highpass filter for your full-range monitors using either their onboard controls or the highpass filter on your subwoofer.

2. Set the lowpass filter on your subwoofer to the same frequency. For example, if you are engaging an 80 Hz highpass filter on your full range monitors, set the variable lowpass filter on your subwoofer to 80 Hz.

From this point you can experiment with the lowpass filter setting that provides the smoothest crossover transition while listening to your favorite music. Again, your subwoofer should naturally extend the low-frequency response of your monitor system. You should not hear any frequency boosts or cuts.

Once your system is properly calibrated, listen to a wide variety of your favorite music and mixes and make any final adjustments. At the end of the day, your ears are the best tools you have in the studio.

A Brief Tutorial on Studio Monitors

	Eris® E4.5	Eris E5™	Eris® E8	Eris® E44	Eris® E66	R65	R80	Sceptre® S6	Sceptre® S8	Temblor®T8	Temblor® T10
Applications	General mixing and production	General mixing and production	General mixing and production	General mixing and production, Soundtrack, Sound design, Center channel, Post-production	General mixing and production, Soundtrack, Sound design, Center channel, Post-production	General Mixing and production High-resolution audio, Soundtrack, Sound design, Mastering	General Mixing and production High-resolution audio, Soundtrack, Sound design, Mastering	General mixing and production, High-resolution audio Soundtrack, Sound design, Surround sound, Post-production, Mastering	General mixing and production, High-resolution audio Soundtrack, Sound design, Surround sound, Post-production, Mastering	Companion for smaller studio monitors, Small post-production suite, Home theater	Companion for any studio monitor, Post-produciton suite Home theater
Unique Benefits	Compact design, Great for small spaces, Onboard Headphone amp	Compact design, Great for small spaces, Transparent audio	Transparent audio, Big bass sound, Low-end punch	Ultra-wide stereo image, Dynamic bass	Ultra-wide stereo image, Dynamic bass	Fast transient response Lifelike sound reproduction	Fast transient response Lifelike sound reproduction Powerful bass	Fast transient response 3-dimensional sound-stage Even mid-range	Fast transient response 3-dimensional sound-stage Even mid-range Powerful bass	Smooth and powerful bass Compact solution for smaller rooms and speakers Variable low-pass filter	Smooth and powerful sub-bass Variable low-pass filter Footswitch bypass
Type	2-way	2-way	2-way	2-way coaxial	2-way coaxial	2-way AMT	2-way AMT	2-way coaxial	2-way coaxial	subwoofer	subwoofer
HF Driver	1" silk dome	1" silk dome	1" silk dome	1.25" diaphragm compression	1.25" diaphragm compression	6.8-inch² (4400 mm²) AMT Equivalent ø: 3" (75 mm)	6.8-inch² (4400 mm²) AMT Equivalent ø: 3" (75 mm)	1" diaphragm compression	1" diaphragm compression	N/A	N/A
LF Driver	4.5" Kevlar	5" Kevlar	8" Kevlar	Dual 4.5" Kevlar	Dual 6.5" Kevlar	6.5" Kevlar	8" Kevlar	6.25" glass-reinforced paper	8" glass-reinforced paper	8" glass composite	10" glass composite
Amplifier (LF /HF)	25W per speaker	45W / 35W	75W / 65W	50W / 35W	80W / 65W	100W / 50W	100W / 50W	90W / 90W	90W / 90W	200W	250W
Crossover Frequency	2.8 kHz	3 kHz	2.2 kHz	2.2 kHz	2.4 kHz	2.7 kHz	2.6 kHz	2.2 kHz	2.4 kHz		N/A
Frequency Response	70 Hz – 20 kHz	53 Hz – 22 kHz	35 Hz – 22 kHz	42 Hz – 23 kHz	38 Hz – 23 kHz	45 Hz – 22 kHz	40 Hz – 22 kHz	42 Hz – 23 kHz	38 Hz – 23 kHz	30 Hz – 130 Hz	20 Hz – 130 Hz
Peak SPL	100 dB	102 dB	105 dB	103 dB	106 dB	104 dB	107 dB	109 dB	116 dB	109 dB	113 dB
User Controls	• Volume • MF Control • HF Control • Low Cut • Acoustic Space	• Volume • MF Control • HF Control • Low Cut • Acoustic Space	• Volume • MF Control • HF Control • Low Cut • Acoustic Space	• Volume • MF Control • HF Control • Low Cut • Acoustic Space	• Volume • MF Control • HF Control • Low Cut • Acoustic Space	• Volume • HF Control • High Pass Filter • Acoustic Space • Energy Conservation On/Off/Query	• Volume • HF Control • High Pass Filter • Acoustic Space • Energy Conservation On/Off/Query	• Volume • HF Control • High Pass Filter • Acoustic Space	• Volume • HF Control • High Pass Filter • Acoustic Space	• Volume • Polarity • Low Pass Filter • High Pass FIlter	• Volume • Polarity • Low Pass Filter • Ground Lift • High Pass FIlter • Footswitch Bypass
Inputs	1- Stereo ⅛" 2- Balanced ¼" TRS 2- Unbalanced RCA	1- Balanced XLR 1- Balanced ¼" TRS 1- Unbalanced RCA	1- Balanced XLR 1- Balanced ¼" TRS 1- Unbalanced RCA	1- Balanced XLR 1- Balanced ¼" TRS 1- Unbalanced RCA	1- Balanced XLR 1- Balanced ¼" TRS 1- Unbalanced RCA	1- Balanced XLR 1- Balanced ¼" TRS 1- Unbalanced RCA	1- Balanced XLR 1- Balanced ¼" TRS 1- Unbalanced RCA	1- Balanced XLR 1- Balanced ¼" TRS	1- Balanced XLR 1- Balanced ¼" TRS	2- Balanced ¼" TRS 2- Unbalanced RCA	2- Balanced XLR 2- Balanced ¼" TRS 2- Unbalanced RCA
Outputs	⅛" Headphone out	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2- Balanced ¼" TRS (full range with 80 Hz HPF option) 2- Unbalanced RCA (full range with 80 Hz HPF option)	2- Balanced XLR (full range with 80 Hz HPF option) 2- Balanced ¼" TRS (full range with 80 Hz HPF option) 1- Balanced XLR (Sub Out)
Cabinet	Vinyl Laminated MDF	Vinyl Laminated MDF	Vinyl Laminated MDF	Vinyl Laminated MDF	Vinyl Laminated MDF	Vinyl Laminated MDF	Vinyl Laminated MDF	Vinyl Laminated MDF	Vinyl Laminated MDF	Vinyl Laminated MDF	Vinyl Laminated MDF
Dimensions (HxWxD)	9.45" (241 mm) x 6.42" (163 mm) x 7.09" 180 mm)	10.24" (260 mm) x 7" (178 mm) x 7.68" (195 mm)	15.12" (384 mm) x 9.84" (250 mm) x 11.77" (299 mm)	7" (180 mm) x 14.3" (365 mm) x 7" (180 mm)	9.8" (250 mm) 18.1" (460 mm) 8.5" (215 mm)	13" (328 mm) x 8" (203 mm) x 10.3" (261 mm)	15" (379 mm) x 9.5" (241 mm) x 12" (309 mm)	13.2" (335 mm) x 9" (230 mm) x 12.2" (310 mm)	15.75" (400 mm) x 11.4" (290 mm) x 13.3" (338 mm)	11" (280 mm) x 10.2" (260 mm) x 12.6" (320 mm)	15.75" (400 mm) x 12.6" (320 mm) x 15.75" (400 mm)
Weight	6.5 lbs. (2.95 kg) ea	10.2 lbs. (4.63 kg)	22.2 lbs. (10.07 kg)	11.9 lbs. (5.4 kg)	23.4 lbs. (10.6 kg)	14.7 lbs. (6.65 kg)	19.8 lbs. (9 kg)	18.8 lbs. (8.53 kg)	24.25 lbs. (11 kg)	21.2 lbs. (9.6 kg)	39.46 lbs. (17.9 kg)

A Brief Tutorial on Studio Monitors

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